SB761
U7P3
R92-07

FOREST PEST MANAGEMENT
Pacific Southwest Region

Report No. R92-07

3420 Evaluation
May 18, 1992

A BIOLOGICAL EVALUATION OF BLACK STAIN ROOT DISEASE, STATELINE TIMBER SALE AREA, DEVILS GARDEN RANGER DISTRICT, MODOC NATIONAL FOREST

John Kliejunas, Plant Pathologist

ABSTRACT

Incidence and impact of black stain root disease was high in portions of the Stateline Sale on the Devils Garden Ranger District. The disease was not found in the adjacent Harp Sale on the Lakeview Ranger District. A visual difference between the areas was site disturbance, with soil disruption highly visible on the Stateline Sale, but not apparent in adjacent areas. Observations suggest that incidence of black stain following management activities in eastside pine stands on the Devils Garden could be minimized by reducing or limiting the amount of ground disturbance.

INTRODUCTION

During May 1991, Bruce Roettgering, John Kliejunas, and Laura Merrill from the Forest Pest Management staff visited several sites on the Modoc National Forest with Bill Merrihew, Forest Silviculturist. One area, in the vicinity of Dip Spring on the Devils Garden Ranger District, was heavily infested with black stain root disease, caused by Leptographium wageneri. The Modoc National Forest subsequently requested a biological evaluation of the area to determine the extent of the infestation, and to provide management options available to curtail the spread of the disease.

LIBRARY COPY
ROCKY MT. FOREST & RANGE
EXPERIMENT STATION

USDA, FOREST SERVICE, PACIFIC SOUTHWEST REGION
State and Private Forestry, Forest Pest Management
630 Sansome Street, San Francisco, California 94111

PROCEDURE

The Dip Springs area, including the Stateline and the Twin Springs Timber Sales on the Devils Garden Ranger District, and portions of adjacent forest land on the Lakeview Ranger District, Fremont National Forest, were examined during the week of September 23, 1991. Resource aerial photography of the area from 1984 (1:24,000 scale) was used in the field to locate roads and terrain, and to mark observed presence and extent of root disease. The areas were traversed by vehicle and on foot. Suspected black stain infection was confirmed by chopping into the base of symptomatic trees and noting characteristic black stain. Areas of infestation were marked on maps and photographs.

Sale records and other information for the Stateline Sale were obtained from Paul Siegel and Omar Gaylord, Devils Garden Ranger District. Records and information from the adjacent Harp Timber Sale on the Fremont National Forest were obtained from Bev Hollars and Bill Patla, Lakeview Ranger District.

OBSERVATIONS

Areas examined were typical eastside pine type forests, with ponderosa pine predominating and only occasional white fir present. Black stain root disease was common in some areas of the Stateline Sale, apparently absent from adjacent areas on the Lakeview District, and was found on only one tree in the Twin Springs Sale.

Stateline Sale

Areas where black stain was observed on the Stateline Sale were marked on 1984 aerial photographs (Figure 1). No attempt was made to mark every individual tree, but only areas where the disease was generally present. Treatments, which consisted of overstory removal in the early 1980's followed by either saw-cutting or shearing over a three year period, are summarized in Appendix I. There did not appear to be any precise relationship between treatment, year of treatment, and occurrence of black stain (Figure 2). The disease was common in 1987 and 1988 treatments, but essentially absent from the 1990 treatment. This may be because of the actual treatment, or simply because the disease was not yet visible in 1991 on the areas treated one year previously. For 1987 treatments, black stain was moderate to severe in areas saw cut and tractor piled, and less conspicious in areas cut and piled with a mechanical shearer. The highest levels of disease incidence were in portions of the sale area that were cut and tractor piled in 1988.

Significant site disturbance was evident in some areas. The amount of site disturbance and degree of black stain appeared to be correlated, with more disease in areas with soil disruption. Some acres had equipment on them three, some four, times. This unusual ground disturbance resulted when slash piles created were subsequently torn apart, spread out, and chipped.

Harp Timber Sale on the Adjacent Fremont National Forest

Areas examined adjacent to and north of the Stateline Sale on the Lakeview Ranger District did not have verified black stain. Portions of these areas were part of the Harp Timber Sale. A summary of stand treatments in the Stateline Sale and ISU and U of H portions of the Harp Sale are presented in Appendix I. In addition to the absence of black stain, the Harp Sale also differed from the Stateline Sale in that little or no site disturbance was evident.

Twin Springs Sale

The area, several miles to the east and south of the Stateline Sale, was thinned in 1986. Slash piles created were not torn or skidded to be chipped, but were burned in place. The area was generally free of black stain, with the disease verified on only one tree. Several annosus root disease centers were present, characterized by dead pine saplings around 30 to 40 inch diameter pine stumps. Tops of some pine crowns had thin foliage. These were associated with fire scorching at the base of the tree from burning of slash piles. There was obviously much less ground/soil disturbance in this area than at the Stateline sale.

MANAGEMENT ALTERNATIVES

There is no effective cure for trees already infected with black stain root disease. Current management strategies for the disease involve either dealing with areas already infested through silvicultural treatments, or using preventive measures to avoid the disease or to limit its spread.

Silvicultural Measures in Infested Areas

1. No action. With no action, some black stain root disease centers in the Stateline Sale area will expand to kill additional trees, while other centers may remain static or disappear. The rate at which a particular disease center grows will vary from center to center depending on microsite factors such as soil moisture and temperature, and differences in susceptibility among host trees. It would seem reasonable to leave the areas alone and monitor the spread of the disease. Monitoring of areas treated in 1990 will be beneficial to determine further the effect of type of treatment on disease development. If or when openings with unsuitable stocking develop, removal of infected trees and planting could be considered.

2. Remove trees in infection centers plus a buffer. In the absence of the host, the black stain pathogen dies out relatively quickly. A buffer with no host roots would prevent local spread of the disease via root contacts. This alternative is best suited to sites that have only a few or small disease centers where large openings would not be created. This is the only method, based on present knowledge, that could limit the expansion of existing infection centers by underground root spread and actually eliminate the

disease. Replanting with non-host species might be possible to some extent, although the very limited numbers of species other than pine in the area suggests that non-pine species are not well adapted to the site.

3. Remove trees in a buffer around infection centers. This alternative could be used where root disease centers are too large to clearcut and where healthy stands nearby need to be protected. A buffer strip one to two trees wide could be cut a certain distance beyond the nearest infected tree. The optimum distance of the buffer from symptomatic trees could be determined by excavating roots to determine the limits of infection. The disease center would remain active as long as there were living trees present, but the buffer would prevent disease spread by root contact into healthy trees. The buffer would have to be cleared of pine seedlings every several years. This method would not prevent spread by insect vectors.

Disease activity in the Stateline Sale area was not typically concentrated in discrete centers, but usually occurred scattered over wide areas. Therefore, alternatives two and three above would have limited utility in the Stateline sale area. Furthermore, the removal of trees within and adjacent to active black stain centers may attract the insect vector and result in increased disease incidence.

4. Strip clearcuts. In areas where the disease is scattered, the stand could be gradually regenerated by laying out strip clearcuts across the area and scheduling their harvest and regeneration over several decades. The objective would be to gradually return infested areas to productive stands when the size of the area is too large to attempt a single regeneration effort. Once regenerated and established, the stocking level in these stands needs to be maintained through thinnings to reduce the likelihood of the black stain fungus being reintroduced.

Preventive Measures

1. Minimize site disturbance. Timber harvest systems for disease-prone areas should be those that cause the least site disturbance. Evidence for an increase of disease incidence with an increase of site disturbance is particulary strong for black stain in Douglas-fir, but circumstantial evidence suggests that the guidelines also apply to black stain in pine. Avoiding soil compaction and soil profile disruption appear particularly important. When tractor yarding, the area covered by skid trails should be minimized and yarding should be restricted to the driest season of the year when the risk of soil compaction is reduced. Soils prone to compaction by heavy equipment even when dry should not be tractor yarded.

2. Minimize tree injury. Damaged trees are often weakened and, at least with Douglas-fir, have been shown to be attractive to insect vectors of black stain. During road building and maintenance, and timber harvest activities, avoid creating flooded or poorly drained areas. Vectors of black stain root disease often visit trees with roots in flooded or poorly drained soils.

3. Thin stands. In general, thinning trees when they are growing well increases their growth rate and vigor, making them more resistant to attack by bark beetles and other pests. Black stain in pine appears to be more common in densely stocked stands, and early treatment of uninfested stands will reduce stocking to levels more appropriate to the site. However, thinning in healthy stands near black stain centers or thinning within black stain centers may attract disease vectors and exacerbate the situation. Odors from freshly cut stump surfaces are attractive to the insect vectors. Within black stain centers, thinning trees might reduce the rate of spread of the disease by reducing the spread of the fungus through root contact.

Studies on timing of emergence of insect vectors of black stain root disease in pines have not been done. The vectors of black stain root disease of Douglas-fir usually emerge in the spring or early summer. Precommercial thinning should be scheduled between the last of June and the first of September to ensure that thinning slash will be red and dry by fall. In principle, this will limit opportunities for insect vector population build-up. Because of the association of increased vector activity with thinned stands of Douglas-fir, some experts consider thinning any host species in a black stain root disease area to be a risky activity. Other experts feel that the benefits of thinning (increased vigor of the leave trees and possible reduction of root contact) outweigh the risks.

DISCUSSION

Black stain root disease incidence is at high and damaging levels in portions of the Stateline Sale on the Devils Garden Ranger District, but absent from adjacent areas on the Lakeview Ranger District and essentially absent from the Twin Springs Sale area. An obvious visual difference between the areas is site disturbance. Soil disruption was highly visible on the Stateline Sale but not apparent in adjacent areas. Circumstantial evidence from records of management activities in the areas and from studies on correlation of increased disease incidence in Douglas-fir and site disturbance suggest that unusual soil disruption played a large part in the high incidence of black stain in the Stateline Sale area. It would seem prudent that, to avoid or reduce black stain incidence in other areas on the District, management practices used on the Stateline Sale should be modified to limit the amount of ground disturbance. The effect of time of year that activities occur and increased probability of black stain in pine is unknown. However, studies in Douglas-fir would suggest that activities during the driest part of the year would be less favorable for disease.

Options available to the District to minimize black stain impact in areas where it currently exists on the Stateline Sale are limited. Clearcutting of centers now and planting may not be reasonable because of the risk of increasing disease incidence as a result of the site disturbance and possible vector attraction that would occur. If black stain was not present, no management activities would occur or be scheduled for about the next 20 years. Leaving the areas alone and monitoring the spread of the disease to determine if or when openings with unsuitable stocking develop could be done. Removal of infected trees and planting in the openings could then be considered.

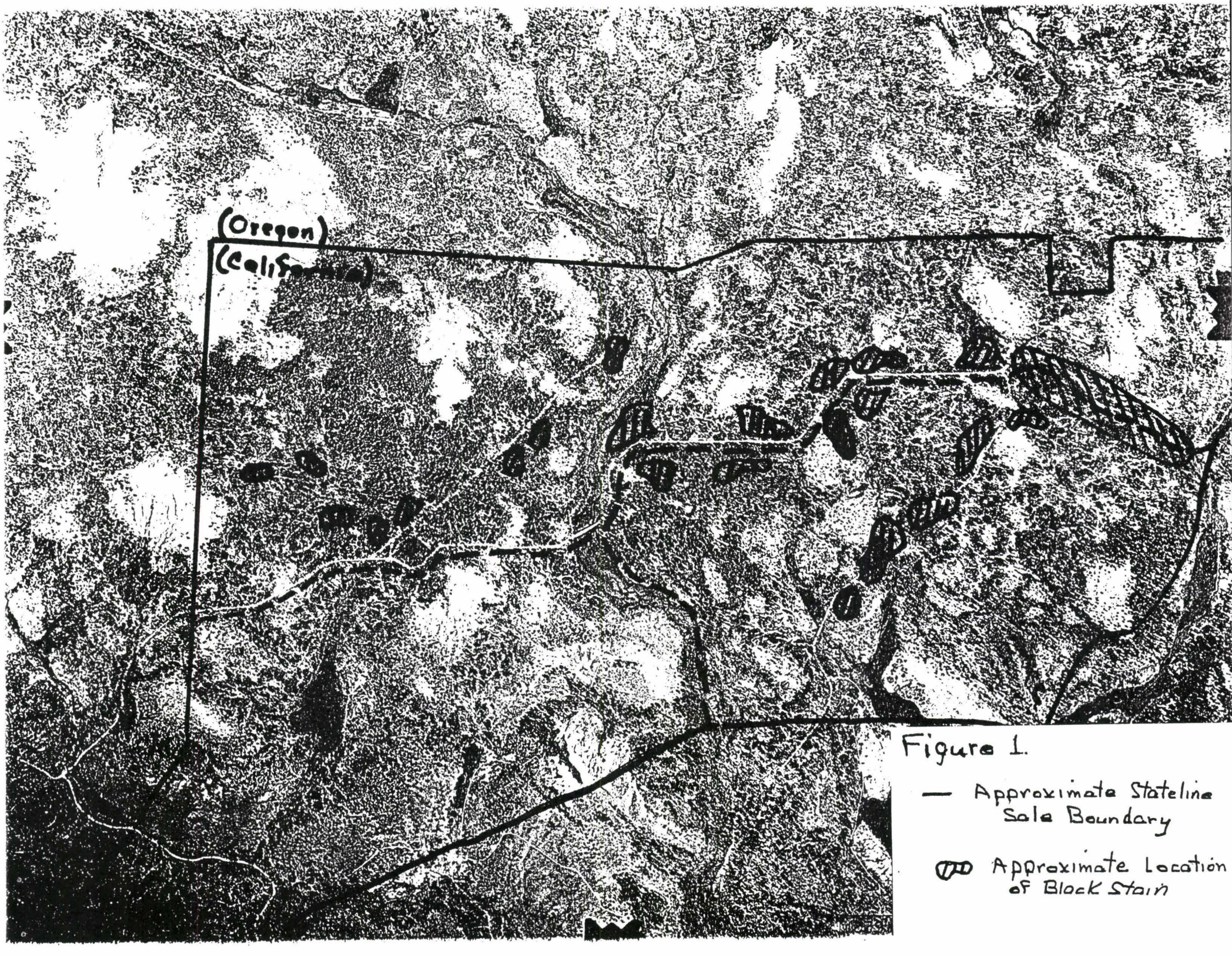

Figure 1.

— Approximate Stateline Sale Boundary

Approximate Location of Block Stain

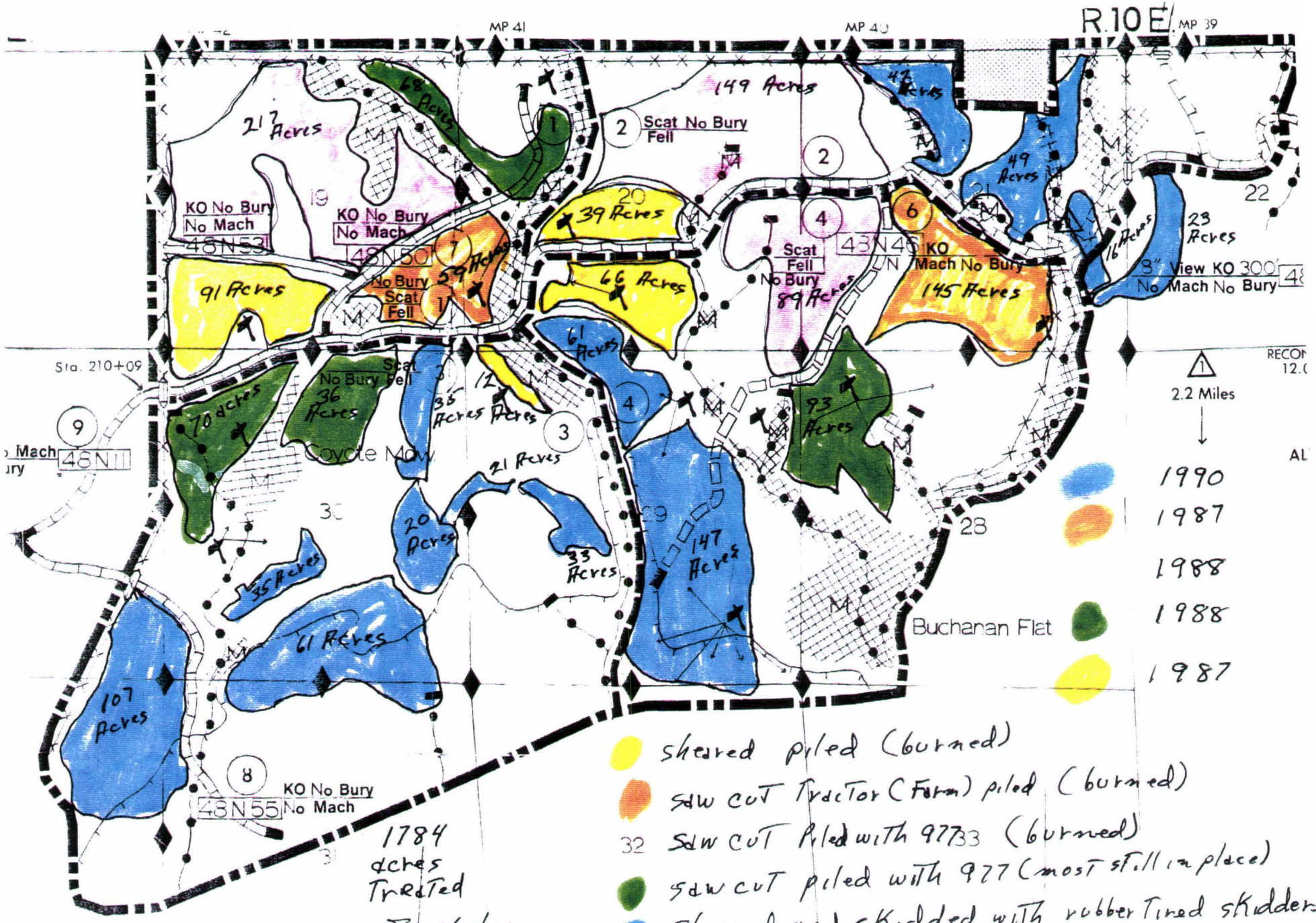
R.10 E
MP 41
MP 40
MP 39
217 Acres
68 Acres
149 Acres
42 Acres
49 Acres
23 Acres
16 Acres
KO No Bury
No Mach
48N53
KO No Bury
No Mach
48N50
Scat No Bury
Fell
39 Acres
Scat
Fell
No Bury
89 Acres
48N46
KO
Mach No Bury
145 Acres
8" View KO 300'
No Mach No Bury
91 Acres
59 Acres
No Bury
Scat
Fell
66 Acres
61 Acres
Sta. 210+09
Scat
No Bury Fell
36 Acres
70 acres
35 Acres
Acres
93 Acres
2.2 Miles
Coyote Mdw
21 Acres
20 Acres
33 Acres
147 Acres
35 Acres
61 Acres
107 Acres
48N11
KO No Bury
No Mach
48N55
Bucharan Flat
1990
1987
1988
1988
1987
1784 acres Treated
9/25/91
Sheared piled (burned)
Sdw cut Tractor (Farm) piled (burned)
Sdw cut Piled with 977 33 (burned)
Sdw cut piled with 977 (most still in place)
Sheared and skidded with rubber Tired skidders

Figure 2.

Appendix I

Some information from the Harp Timber Sale on the Oregon side, and the Stateline Timber Sale on the California side, follows:

Harp Timber Sale (total = 2,907 acres)

ISU (Harp 8) -- ?
U of H (Harp 9) -- 56 acres

ISU & U of H -- summer, 1983 -- logged by tractor (other notes say completed in 1983; tractor logging from 1980-1983)

spring/summer, 1985 -- pre-commercial thinned (SPC) (20 X 20 spacing)
normally would pile before SPC

summer, 1985 -- logging slash machine piled

fall, 1985 -- piles burned

spring, 1987 -- tried unsuccessful underburning

Stateline Timber Sale (total - 1784 acres)

logged (overstory removal) -- 1982 through 1985, June - November

pre-commercial thinned --
1987 -- sheared, piled (burned)
1987 -- saw-cut, farm tractor piled, burned
1988 -- saw-cut; piled with 977, burned
1988 -- saw-cut; piled with 977, most still in place
1990 -- sheared and skidded with rubber-tired skidders

Appendix II

PEST BIOLOGY

Black stain root disease is caused by the fungus Leptographium wageneri (Verticicladiella wageneri, sexual stage Ophiostoma [Ceratocystis] wageneri). In California the fungus has three host-specific strains that infect either ponderosa and Jeffrey pine, singleleaf pinyon pine, or Douglas-fir. In most situations the fungus does not cross over between species, even in mixed species stands. Resistance to black stain root disease in single-leaf pinyon, Jeffrey and ponderosa pines, and Douglas-fir has not been identified.

Initiation of disease centers probably occurs when spore-carrying, cambium-feeding beetles (probably scolytids and curculionids) invade tree roots and transmit the spores of the fungus to the tree. The fungus then grows in the wood of the root toward the root collar. Insect vectors in Douglas-fir and ponderosa pine roots have been identified (Harrington et al. 1985, Goheen and Cobb 1978). Similar vectors in pinyon pine have not been identified. In Douglas-fir, vectors appear to be attracted to resin (Rudinsky and Zethner-Moller 1967), thus wounding trees or thinning stands may put them at risk for infection. There is strong evidence that vectors are attracted to thinned or disturbed stands of Douglas-fir (Hansen 1978, Lownsbery 1988, Harrington et al. 1983, 1985, Witcosky et al. 1986). Similarly, black stain in ponderosa pine in the central Sierra has been observed to be associated with disturbance such as logging (Cobb, pers. comm.). Thinning studies in ponderosa pine have not been done.

Once the fungus becomes established in a tree, it spreads locally between trees through rootlet contact or hyphal growth through the soil for short distances and direct infection of small feeder roots. The rate of underground spread in a ponderosa pine stand is highly variable and dependent on species composition, stand density, and site; on the Georgetown Divide, El Dorado County, the average annual radial spread was 4 feet (range 0 to 20 feet). The rate appears to be faster in Douglas-fir. In pinyon the disease has been estimated to spread 40 feet in 6 years (Wagener and Mielke 1961). However, there is evidence that in ponderosa pine some centers do not enlarge (Cobb et al. 1982). It is not known if there are biotic (other than death of all available host trees) and/or abiotic factors that eventually limit the growth of disease centers. An individual disease center may grow, remain static, or even die out. One scenario is that so long as host material is present, the disease will persist in an area. Trees regenerating within centers may escape the disease for decades, but eventually the roots may grow in the vicinity of infected roots, become infected, and die. The rate at which a particular disease center grows and regeneration within the center becomes infected could vary from center to center depending on microsite factors (e.g., soil moisture and temperature), and differences among host trees and possibly between particular isolates of the pathogen.

The disease is not long-lived in the absence of live hosts and is thought to only survive a few years in stumps and roots, in contrast to annosus root

disease and other root decay fungi which can survive for decades as saprophytes.

The disease can be identified in a tree by the dark brown to black stain of the xylem at the root collar and in roots. This stain occurs as arcs that follow the annual rings. The amount of stain around the bole varies among trees. It may involve only a small part of the tree's circumference or it may encircle the tree. The stain may be one to many annual rings deep. The stained xylem is at the base of the tree and sometimes only in the roots. Blue-stain fungi (associated with bark beetle attack and not causing a root disease) cause blue to black staining of the wood, and the stain grows through the xylem rays and is visible in cut stumps as wedge-shaped discoloration rather than as arcs. Furthermore, since bark beetles frequently attack diseased trees, blue stain fungi may obscure the signs of black stain, making diagnosis difficult in bark beetle-killed trees.

Infected trees undergo gradual to rapid crown decline prior to mortality. Symptoms of crown decline include reduced terminal growth, needle yellowing and shortening, and premature loss of foliage. Douglas-firs may have grayish-blue resin streaming from the bark at the base of the tree above the stained area.

In ponderosa pine in the Sierra, the disease appears to be more aggressive in moist soil, possibly because of increased survival and growth of fungal hyphae between tree roots. The fungus has been reported to grow better at low temperatures ($15^{o}C$), thus exposure of the soil to solar radiation in an open stand may reduce the rate of spread of the pathogen. Further, in ponderosa pine the disease appears to spread more rapidly in pure, overstocked stands, probably because of the proximity of susceptible roots.